Science JOPs: JOP 014

Title: SOLAR WIND FROM CORONAL HOLES

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SOHO Instruments involved: UVCS, SUMER, CDS, LASCO, EIT, MDI

Collaborating GBO: Possible collaborations: white light coronagraphs (polarization), radio observatories

Collaborating S/C:

Campaign: yes

First proposed: SPWG January 1995

Object: Coronal Holes

SOLAR WIND FROM CORONAL HOLES (JOP 014)

Objective
To identify and characterize the coronal sources of the solar wind: Coronal Holes contribution

Scientific Case
The primary scientific goals of the observing program are the following:

- to identify and characterize the coronal sources of the solar wind,
- to identify and understand the dominant physical processes that accelerate the solar wind.

(See JOP 006)

This observing program is dedicated to coronal holes observed preferably at high latitudes, but not necessarily in polar regions (Jop 002 deals with the physics of polar coronal holes). Although the best seeing conditions are indeed reached for polar coronal holes, being the contribution to the emission along the line of sight from active regions or the quiet sun negligible, in this case the characterization of the base of the coronal hole by means of disk observations is not at all optimum. For non-polar coronal holes this basic information on the boundary conditions of the solar wind can be obtained with accuracy observing the coronal hole on the disc a few days before approaching the limb, when the coronal hole region can be observed in the extended corona with the coronagraphs. The contribution to the emission from active regions adjacent to the coronal hole should not significantly influence the extended corona for large coronal holes during solar minimum.

This program is limited to:

- determine the mass input and energy and momentum deposition in the solar wind for:
  Coronal Holes
- distinguish between thermal models and models requiring momentum deposition in the extended corona.

Observables

- extended corona (UVCS, LASCO)

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  determine kinetic temperature for protons and heavier ions, electron density, outflow velocity of the corona from the limb up to 1.7 $R_\odot$, in the solar wind region.

- inner corona (CDS, EIT, SUMER, MDI)

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  determine:

  – electron density and temperature
  – differential emission measure on disk near the limb and possibly up to 1.5 $R_\odot$
  – non-thermal velocity maps in
    - transition region
    - coronal lines
  – fine (2") magnetic structures in the potential solar wind sources (at least at the beginning of the tracing of the target).

Pointing and Target Selection

It is desirable to begin to observe the target region (coronal hole) a few days before arrival at the limb, in the inner corona, in order to fully characterize the solar wind source. The coronagraphs shall start the joint observation when the target is approaching the west limb, continuing for the period of visibility at the west limb.

Observations

UVCS

The UVCS observations consists of a mirror scan.

MIRROR SCAN

Channel I: Ly α, Fe XII 1242, N V 1239, S X 1196 (S X 1213) profiles
Channel II: O VI 1032, O VI 1037, Mg X 610, Ly β 1026, Si XII 499, Si XII 521, Ly α profiles
Channel III: VL polarized 4500–6000 Å.
To determine electron density, proton/ion kinetic temperature, outflow velocity.

	Ch I – H Ly α	Ch II – O VI
Initial IFOV position	1.5 $R_\odot$ at the target latitude	$\|\|$ to the limb
Instantaneous FOV (IFOV)	30' x 14"	30' x 28"
Slit width	0.05 mm	0.1 mm
Spectral resolution	0.28 Å	0.36 Å
Area element (n. pxls)	28" x 14" (2 x 2)	28" x 28" (8 x 8)
F.O.V.	1.5– 1.7 $R_\odot$	
Average dwell time	variable with height	
Total time	10. h	

Observing Sequence JOP–14

Exposure time	600 sec	
Dwell time	variable with height	
Total bins	40000	
Polarizer motion	each	600 sec
	Channel 1 (Ly alpha)	Channel 2 (OVI)
Slit Width	0.05 mm (0.28 Å, 14”)	0.1 mm (0.36 Å, 28”)
Grating Position	95000	185000
Mask:	GPS2-LYA	GPS2-OVI
Binning along the slit	4 pxls=28”	4 pxls=28”
Binning in λ	2 pxls=0.28 Å	2 pxls=0.18 Å
Full spatial range	90 bins	90 bins
Selected spatial range	64	64 (72-328)
Spectral bins	625	available for transmission
Spectral Range	column interval	column interval
	500–879 (190 b)	280–469 Si XII 521–OVI 1037 (95b)
	–Fe XII 1242–NV 1239–	OVI 1032–Ly β 1026
	Lyα 1216–SX 1213,1196	Si XII 499 Mg X 610, Lyα+wings
		700-1019 (160b)
Total spectral bins	190 bins	255 bins
Bins per channel	190x64= 12160	255x64 = 16320
Total bins	28480	
Field of View	30’x 14”	30’ x 28”
Scan step	variable	
Scan time	(for photon integration)	34200 s (9.5 h)
Scan time	(including polarizer motion)	35340 s (**9.8 h**)
Number of scans	1	
Total time	**10 h**	

Streamer
N–Predicted Counts)

$R_\odot$	Δt	Ch1
	(sec)	pxl^2
1.50 14400 4x 2 1.5e+04 4x 4 2.2e+03 1.3e+03 1.70 19800 4x 2 1.7e+04 4x 4 1.9e+03 1.1e+03		

CDS

CDS primary diagnostic from coronal holes will be determination of temperature and density, and identification of small scale structures within the coronal hole. Several CDS studies have been proposed, for example, TGRAD (temperatures gradient in a coronal hole from Grazing Incidence measurements). Here we describe an observing sequence using Normal Incidence spectra, based on studies CHOLE, CHSTR, BOUND (see the CDS Blue Book). CDS parameters are given below:

Study Details	Spectrometer:	Normal Incidence
	Slit:	2 x 240 arcsec
	Raster Area:	4 x 4 arcminute
	Step (DX, DY)	2 arcsec, 0 arcsec
	Raster Locations:	120 x 1 = 120
	Exposure Time:	60 s
	Duration of raster:	7200 sec (126 min) incl. overheads
	Number of rasters:	open
	Total duration:	open

Line selection: Fe VIII (370.43), Fe X (365.57), Fe XI (356.54), Fe XII (364.47), Fe XII (338.17), Fe XIII (348.18), Fe XIV (334.17), Fe XVI (335.40), Si IX (349.87), Si IX (341.95), Mg IX (368.06), Mg X (624.94), O III (599.59), Ne VI (562.83), He I (584.33)

Bins Across Line:	15
Telemetry/Compression:	truncate to 12 bits 33 s/exposure = 15 lines x15 bins x120 pixels x12 bits /10 kbits/s
Pointing:	to pre-planned coronal hole site
Flags:	Will not be run in response to interinstrument flag and will not be run with CDS as flag Master

Solar Feature Tracking: May be used during prolonged observations if the target is near the disk center

SUMER

Two different scans will be done: one for disc observation, and another for off-limb observations.

- Disc observations:

Slit:	4 (1" x 120")
Raster area:	2 x 4 arcmin
Step:	2 (0.76")
Line selection:	
	(1) Lbeta(1025), O VI(1032) and O VI(1037)
	(2) Mg X (609), Mg X (624), N V (1242)
Exposure time:	15 sec
Format:	50 x 120 pixels
To be repeated as needed	

- Off-limb observations:

Slit:	1 (4" x 300")
Raster area:	2' x 5'
Step:	10 (3.8")
Line selection*:	
	(1) Lbeta(1025), O VI(1032) and O VI(1037)
	(2) Mg X (609), Mg X (624), N V (1242)
Exposure time:	100 sec
Format:	50 x 360
To be repeated as needed	

  Note
  * (The C II 1037 line and the N I 1242 lines will be used to measure the scattered light level; they are within the 50 pixels O VI and N V windows)

MDI

As in JOP 006.

LASCO

The LASCO primary observables for coronal hole structures will be to determine electron densities, kinetic temperatures, velocities associated with the hole, structures within the hole and structures at the boundaries of the hole. The observations are from the C1 telescope. The C2 observations to obtain electron densities will be taken as part of the normal LASCO synoptic program.

Telescope: C1 Passbands: Fe X and Fe XIV FOV: 512 x 256 pixels (48 x 24 arc min) Wavelengths: 6 + 1 off band Resolution: Full spatial resolution

Compression: Rice (lossless) TM Downlink: 21 minutes Cycle Repeat: Once at beginning, middle and end of period

A cycle will require several repeated exposures at each wavelength step with on-board summing to be able to obtain a total exposure time at each wavelength step of about 5 minutes.

EIT

Synoptic observations.